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ORIGINAL ARTICLE

Diagnostic accuracy of contrast enhancement MRI versus CTA in diagnosis of intracranial aneurysm in patients with non-traumatic subarachnoid hemorrhage



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KEYWORDS

Contrast enhanced magnetic resonance angiography;
Computed tomography;
Angiography;
Digital subtraction angiography;
Intracranial aneurysm

Abstract *Aim of the study:* The most common cause of spontaneous SAH is the rupture of cerebral aneurysm. So it is very important to exclude it from circulation as soon as possible using endovascular therapy. The aim was to determine whether contrast enhancement magnetic resonance angiography (CEMRA) is preferable to computed tomography angiography (CTA) in detection of intracranial aneurysm in patients presenting with non-traumatic subarachnoid hemorrhage (SAH).

Patients and methods: Twenty-five patients who presented with non-traumatic SAH underwent CEMRA and CTA for detection of aneurysms. Digital subtraction angiography (DSA) was used as standard of reference.

Results: CEMRA and CTA were done for all patients. A total of 22 aneurysms were detected in 25 patients. 15 patients with single aneurysm, 2 patients with two aneurysms, one patient with 3 aneurysms and in 7 patients no aneurysm was found. CEMRA and CTA angiograms were interpreted for the detection of aneurysms, site and size.

Conclusion: The diagnostic performance of CEMRA does not significantly differ from that of CTA in patients presenting with SAH.

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1. Introduction

The most common cause of non-traumatic SAH is rupture of an intracranial aneurysm which accounts for about 85% of SAHs (1).

Intracranial aneurysms are present in about 2% of asymptomatic adults (2). Most aneurysms (80–85%) are located in the anterior circulation, commonly at the origins of the posterior or anterior communicating arteries or the middle cerebral artery bifurcation; posterior circulation aneurysms are most often seen at the basilar tip or posterior inferior cerebellar artery origin (1,2).

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Table 1 Reason for exclusion.

	No. of patients
Contraindication for one of the modalities	4
Patient with previous surgical clipping	1
Poor general condition	21
Refused the study	12
Total excluded	38

Table 2 Number of cerebral aneurysm.

Aneurysm	No. of patients (%)	No. of aneurysms
Single aneurysm	15 (83.3%)	15
Multiple aneurysm	3 (16.7%)	7
Total	18 (100%)	22

Table 3 Locations of intracranial aneurysm.

	No. of aneurysms
Internal carotid artery: posterior communicating artery, carotid tip and ophthalmic artery	5 aneurysms (21.5%)
Anterior cerebral artery: anterior communicating artery	6 aneurysms (29%)
Middle cerebral artery	7 aneurysms (31%)
Vertebrobasilar junction artery and basilar tip	4 aneurysms (18.5%)

Table 4 Comparison between CTA, CEMRA and DSA in detection of aneurysms.

	CTA	CEMRA	DSA
True positive	19	18	20
False negative	1	2	1
False positive	2	2	1

Table 5 Sensitivity, specificity, PPV, NPV and accuracy of CTA according to the size of the aneurysm.

Size of the aneurysm	Sensitivity	Specificity	PPV	NPV	Accuracy
> 5 mm	100%	100%	100%	100%	100%
< 5 mm	84.8	86	90	84	87
< 3 mm	75	94.4	79.1	74	95.6

Rupture risk is predicted by the aneurysm size and location, with risk increasing significantly for aneurysms greater than 7 mm in diameter, and an increased rupture risk is for those arising from the posterior communicating arteries or posterior cerebral circulation (3).

When SAH is diagnosed, selection of imaging modality is essential to ascertain whether a cerebral aneurysm is present or not (4,5).

CTA is the modality generally used for its logistic and diagnostic reasons. It is widely available on 24 h basis and for its cost effectiveness (6,7).

Some advantages have been recorded to MRA over CTA as follows: potentially harmful ionizing radiation is absent, and no iodinated contrast agent is administered. However, flow dependant MRA sequences like time of flight MRA can suffer from signal loss, due to in place saturation or turbulent flow inside the aneurysm. CEMRA has shorter acquisition times than flow dependant MRA sequences and does not suffer from signal loss due to turbulent or slow flow or as a result from spin saturation in larger scan volumes. It might therefore be advantageous in the depiction of intracranial aneurysms (8,9).

CEMRA may be a preferable diagnostic tool. Besides its very small risk of nephrogenic systemic sclerosis or adverse reactions on gadolinium based contrast agents, the major disadvantage of MRA is that it requires transfer of the patient to the MRI room, where as additional CTA requires little extra effort since CT is the standard used to confirm the presence of SAH. Because catheter DSA is an integral part of the coiling procedure, and it is still the standard of reference for the detection of intracranial aneurysms, DSA is used as gold standard in this study (10,11).

In this prospective study the aim was to assess the accuracy of CEMRA in comparison with CTA in detection of intracranial aneurysms in patients with non-traumatic SAH.

1.1. Patients and methods

This study was conducted according to the guidelines of the Research Ethics Committee approval and informed consent was obtained from all patients.

From March 2013 to February 2014 all adult patients with diagnosed non-traumatic SAH were eligible for inclusion in this study. The inclusion criteria were as follows: all consecutive adult patients who had clinical symptoms of non-traumatic subarachnoid hemorrhage or cerebral aneurysm diagnosed by CT were eligible to enter the study. Diagnostic catheter DSA was performed within 3 days after CTA and CEMRA to all patients as standard of reference.

All patients who met the study inclusion criteria underwent CTA and an additional CEMRA study before endovascular therapy and within 48 h after CTA, however the CEMRA study did not delay the treatment.

The exclusion criteria were: absolute contraindication for one of the modalities, patients with previous surgical clipping or endovascular coiling of intracranial aneurysms, poor general condition and patients who refused to undergo the procedures (Table 1).

Thus, this prospective study was done on 25 patients (18 females and 7 males) with age ranging from 40 to 74 years (mean age was 58.7 ± 15.3).

1.1.1. CTA

CTA was performed on 4-slice multidetector – row spiral CT scanner (Toshiba Aquilion Tokyo, Japan). Scan parameters were: 120 kV, 200 mAs, collimation width 0.9 mm, pitch 0.67, field of view 230 mm, matrix 512×512 . 0.5 mm slice

Table 6 Sensitivity, specificity, PPV, NPV and accuracy of CEMRA according to the size of the aneurysm.					
Size of the aneurysm	Sensitivity	Specificity	PPV	NPV	Accuracy
> 5 mm	100%	100%	100%	100%	100%
< 5 mm	96.9	95	90	92.5	96.2
< 3 mm	91.7	88.9	79.1	86	90

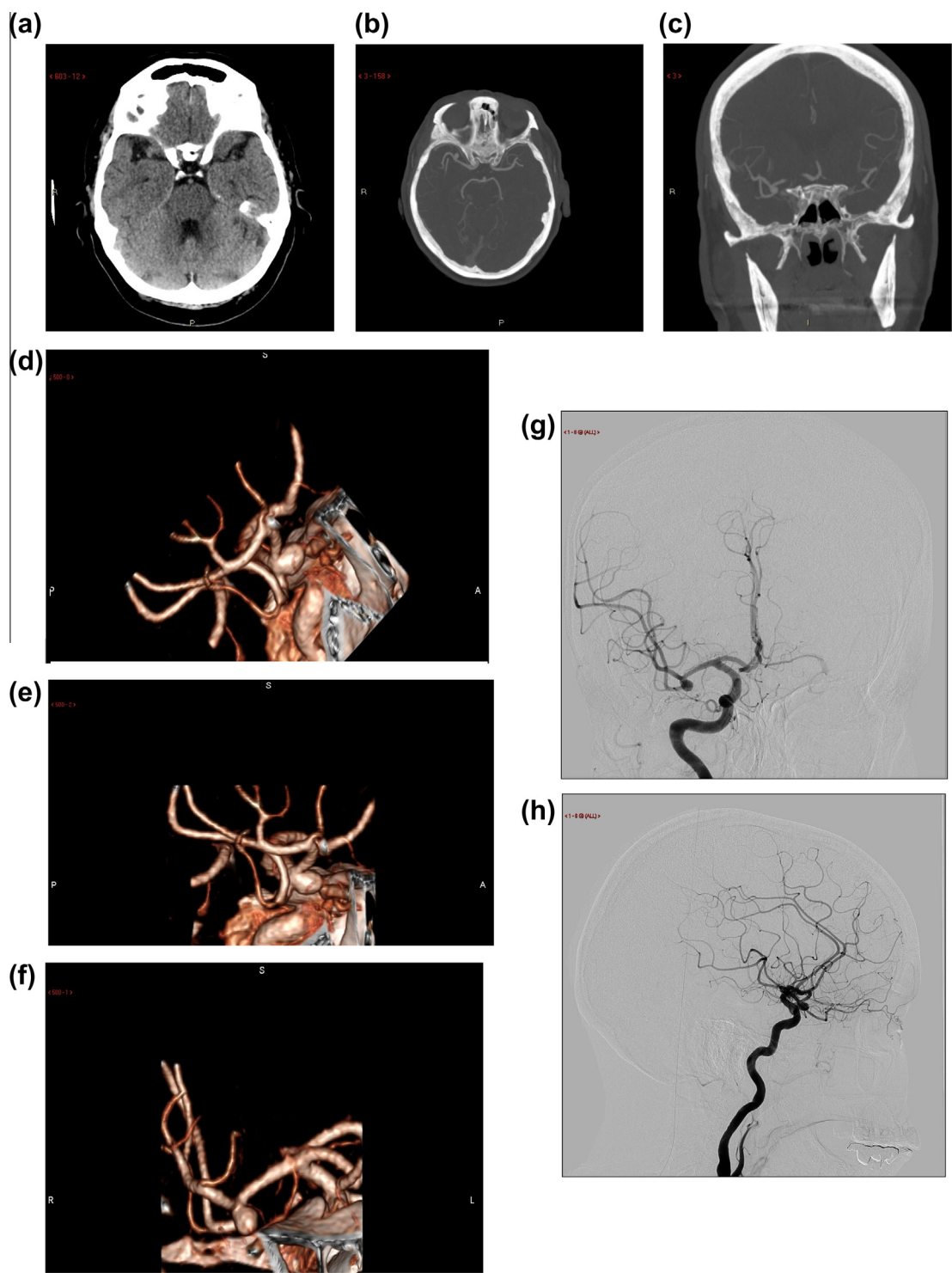


Fig. 1 69-year-old female patient presented with balance problems and headache. (a and b) Axial and coronal maximum intensity projection (MIP) images. (c–e) VR image shows the aneurysm. (f and g) Anteroposterior and lateral projections of right internal carotid artery DSA. (h) VR reconstruction of the CEMRA scan.

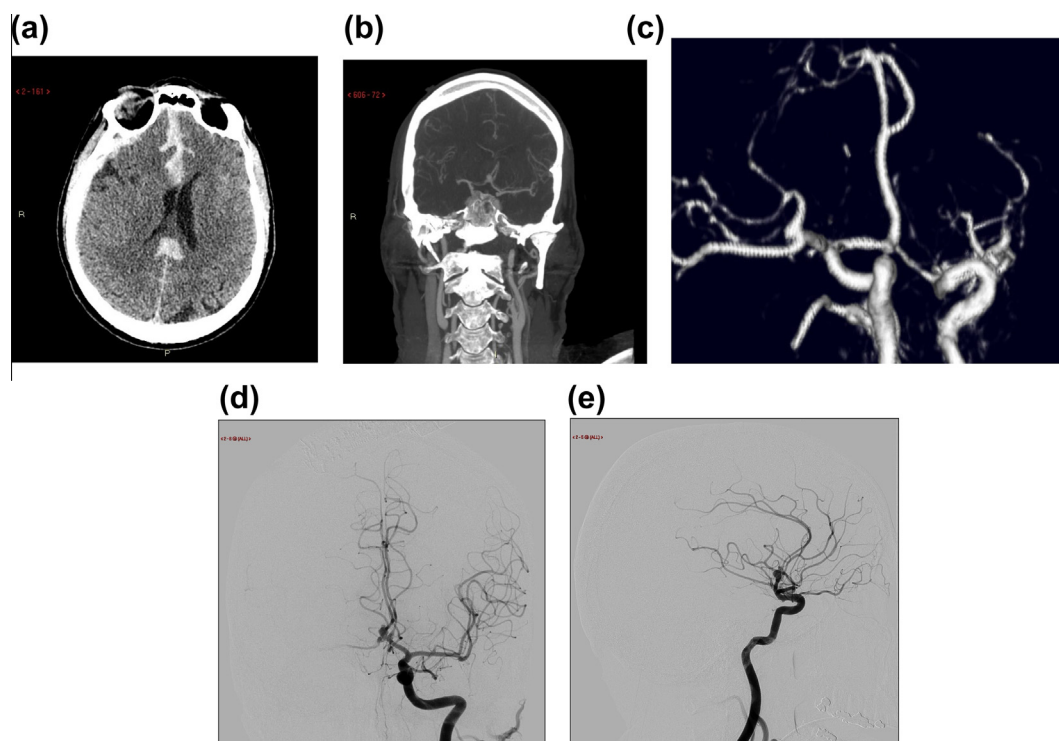


Fig. 2 57-year-old female patient presented with severe headache and blurring of vision. (a) An axial non-contrast CT shows subarachnoid hemorrhage filling the interhemispheric fissures. (b) Coronal maximum intensity projection (MIP) image shows the aneurysm. (c) Oblique projection of a volume rendered reconstruction of the CEMRA shows a left anterior communicating artery aneurysm. (d and e) DSA of the left internal carotid artery.

reconstruction was used. A nonionic iodinated contrast medium; Iopromide 350 mg/ml (Ultravist) was administered via a 20–22 gauge needle intravenously in the antecubital fossa at 4 ml/s with volume 100 ml. The contrast medium was administered with an automated injector and it is followed by flush of 40 ml isotonic saline at 4 ml/s.

A detection slice through the intracranial arteries was made for the Toshiba scanner, the scans were started upon the detection of arrival of the contrast media in this slice.

The direction of scanning was caudal to cranial starting from the first cervical vertebrae to the vertex. Bony structures were subtracted from the contrast scan either automatically or by using manual segmentation.

1.1.2. MRA

MRA was performed on a 1.5 T Toshiba using head coil (Avanto Tokyo, Japan). The scan parameters were: parallel imaging TR 5.4/TE 1.68 ms, flip angle 35, FOV 256 mm, matrix 512, slice thickness 0.4 mm coronal orientation (parallel to basilar artery). Contrast material used was gadopentetate dimeglumine (Magnevist, Bayer Schering, Germany) given intravenously of 0.1 mmol/kg and it is followed by flush of 25 ml isotonic saline at 3 ml/s.

1.1.3. DSA

All DSA were performed transfemorally with 5 F catheter by using a DSA unit (Siemens, Netherlands) with image intensifier matrix of 1024 × 1024 pixels. DSA was performed with bilateral selective internal carotid artery injections, unilateral vertebral artery injections and bilateral as necessary. Flush

autography was performed by an automatic power injector. All 4 brain feeding arteries were catheterized and imaged. 10 ml of non-ionic contrast material (320 mg of Iopromide) was used at a rate of 4–8 ml/s for each injection.

Standard anteroposterior, lateral projections and oblique for intracranial aneurysm and anteroposterior and lateral for vertebral arteries were routinely acquired. Additional angiographic projections were obtained to better visualize an aneurysm.

1.2. Image interpretation and analysis

CTA and MRA data were sent to a post-processing workstation and were interactively evaluated.

The reader of CTA and MRA cases was blinded to the DSA results primarily.

The following were recorded: the presence of intracranial aneurysm, location of the aneurysm, size and number of the aneurysm. Sensitivity and specificity for the detection of aneurysms were calculated.

2. Results

A total of 63 patients entered the hospital with a diagnosis of SAH, 38 patients (60.3%) were excluded for reasons outlined in Table 1 whereas 25 patients were included.

There were 7 patients (28%) without aneurysms. 15 patients (60%) harbored one aneurysm, 2 patients (8%) had 2 aneurysms and one patient (4%) harbored 3 aneurysms, making a total of 22 aneurysms, this is given in Table 2. The locations of cerebral aneurysm are given in Table 3.

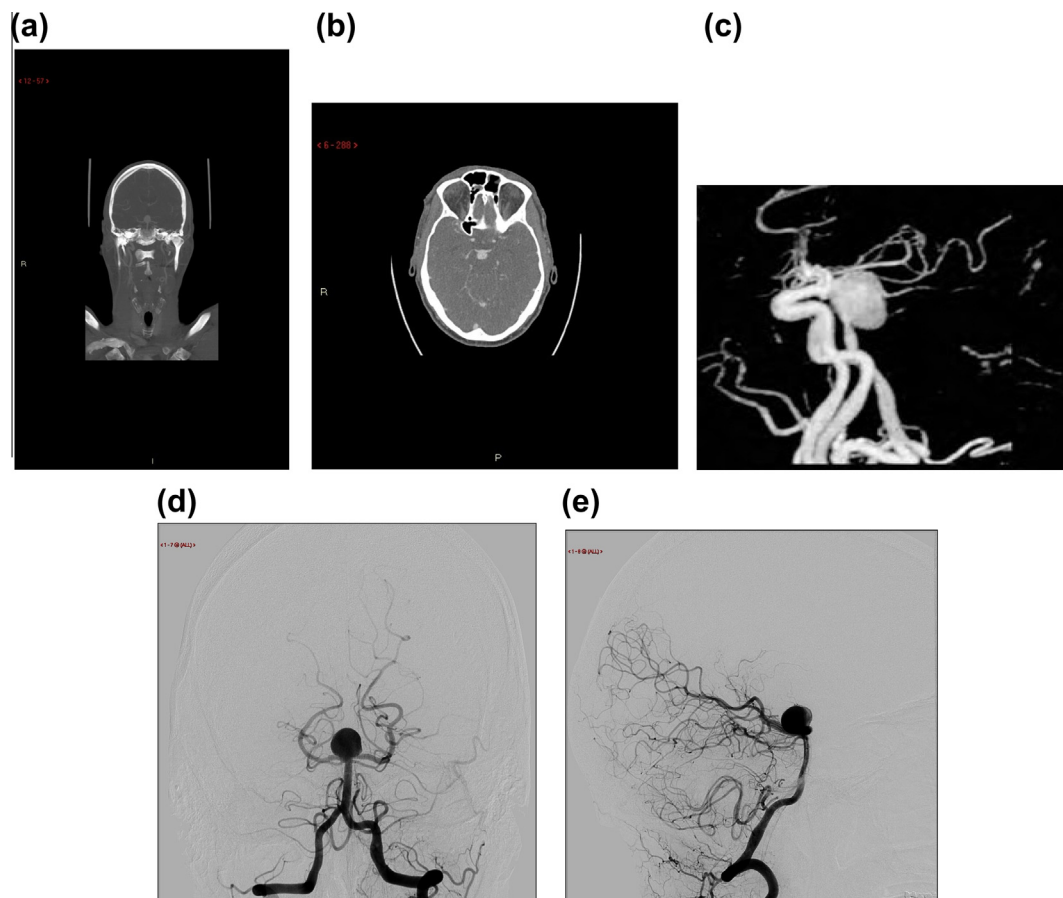


Fig. 3 70-year-old male patient presented with severe headache and disturbed consciousness level. (a and b) Coronal and axial maximum intensity projections (MIP). (c) Oblique projection of CEMRA. (d and e) DSA of images in coronal and lateral projections confirm the presence of the basilar tip aneurysm.

All patients included in this study underwent DSA as part of the diagnosis work-up and these studies were used as the standard of reference.

Comparison between CTA, CEMRA and DSA in detection of aneurysms is outlined in Table 4.

The sensitivity and specificity for the detection of an aneurysm by CTA and CEMRA are given in Tables 5 and 6. There was no significant difference between the sensitivity and specificity of CTA and CEMRA according to the size of the aneurysm.

The aneurysms found in this study population, 59.1% (13 out of 22) of the aneurysms were smaller than 5 mm and 22.7% (5 out of 22) were smaller than 3 mm. Examples of intracranial aneurysms are given in Figs. 1–3. Among 22 aneurysms detected, 2 aneurysms were detected by CEMRA, both very small that were not confirmed by DSA. One false +ve result appeared as infundibular dilatation at the origin of the left posterior communicating artery, the other one was artifact of the vessel wall. None of these 2 false +ve results was registered by CTA. False +ve result of CTA was one aneurysm in two patients located at the posterior inferior cerebellar artery, they were dysplastic vertebral artery. These false +ve results of CTA were not seen on CEMRA or DSA. Thus, sensitivity of detecting small aneurysms was slightly better with CEMRA than with CTA, however the difference was not significant, this is given in Tables 5 and 6.

3. Discussion

Demographic distribution of our patients was concordant with Van Gijn et al. who found that the peak presentation is between 40 and 60 years with female preference (2).

Delgado et al. (12) stated that about 75% of patients have two aneurysms, 15% have three aneurysms and 10% harbor more than three aneurysms. These results do not agree with the current study as we found that 83.3% of the studied population harbor single aneurysms and 16.7% harbor multiple aneurysms.

In the present study we found no significant difference between CTA and CEMRA in detection of intracranial aneurysms, these results are in line with meta-analysis of White et al. (13) who calculated a pooled sensitivity and specificity with 95% confidence interval for detection of aneurysms of 90% (88–92) and 86% (79–91) for CTA and 87% (84–90) and 95% (91–97) for MRA respectively.

In the current study sensitivity is 84.8% for CTA in aneurysms smaller than 5 mm that decreased to 75% for aneurysms smaller than 3 mm. The CEMRA sensitivity was 96.9% in detecting aneurysms smaller than 5 mm that decreased to 91.7% for aneurysms smaller than 3 mm. These results are in accordance with the meta-analysis of White et al. (14) who found that the sensitivity decreased to 57% for CTA and

35% for MRA for aneurysms smaller than 5 mm and decreased to 61% and 38% for CTA and MRA respectively for aneurysm smaller than 3 mm.

It seems that the improvement in the diagnostic scanning technique had led to better detection of small aneurysm especially with MRA (14–16).

Patients with negative CTA and CEMRA underwent diagnostic DSA, specificity is more important than sensitivity (17–19). In the current study the specificity for CEMRA is lower than that for CTA although not significantly so.

There are some MRI drawbacks which make this modality less popular e.g. less availability than CT, monitoring of the patient in MRI room is more difficult. Contraindications to MRI as implanted pacemakers. The use of gadolinium chelates as a contrast agent for CEMRA involves the risk for nephrogenic insults (20).

Although MRI has the advantages of not using iodinated contrast media and ionizing radiation (20,21).

4. Conclusion

It has been shown that CEMRA performance did not differ significantly from that of CTA in detecting aneurysms in patients with SAH (21,22).

Conflict of interest

The authors have no conflict of interest to declare.

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